THE LAYOUT OF THE HEEL AND SOLE TRIMMING DEPARTMENT AT THE REVERE RUBBER COMPANY. CHELSEA, MASS.

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Boston, Mass.,

May 24, 1929.

Professor A. L. Merrill,

Secretary of the Faculty,

Massachusetts Institute of Technology,

Dear Sir:

In accordance with the requirements for graduation we herewith submit a thesis entitled "The Layout of the Heel and Sole Trimming Department at the Revere Rubber Company, Chelsea, Mass."

We should like to express our gratitude to Professor Raymond for his supervision and suggestions and also Mr. George Parker, Assistant Superintendent of the Revere Rubber Company.

We want also to thank Mr. Curry, Industrial Relations Manager, Mr. Scribner, Superintendent of the Plant, and the staffs of the drafting-room, the cost accounting and the time-study departments for their patience and direct aid.

Respectfully submitted,

PREFACE.

The proper layout of machines and equipment is necessary to secure maximum efficiency and maximum production in any business enterprise. The thing to do is to determine what this "proper layout" is. Of course we know or should see, that in problems of this type there is more than one answer and two men will turn in two different solutions according as their points of view vary, and we shouldn't know which is the proper one. The way to find out is by results obtained. It would seem therefore that layout problems are solved by the "cut and try" method and this is true to a certain extent. There are, however, principles to be followed in layout work just as there are in any part of scientific management and although it is possible to get more than one correct answer using these principles, nevertheless the principles must be used to get either of them. The layout principles to be followed are*
(1) Straight line flow of work in so far as possible, This implies the processing of the product in one direction or a series of directions, with a minimum number of retraced steps or backward movements. The

*Indirect quotations from Lansburgh's "Industrial Management"

fulfillment of this principle is made complicated when a machine is not served with enough work to keep it busy on one operation and another must be also performed to keep it continuously busy. This supplementary work might necessarily be brought from another part of the factory and could not very well be made to conform with straight line flow.

(2) Short moves: The layout should be such as to result in as short a moving of the work as possible. This is particularly important where the product is heavy or unwieldy and is not so important where the product is light and compact. In placing workers too close together the advantages of short moves may be overbalanced by a greater loss due to this excessive crowding which shows itself by a decreased production.

(3) Adequate internal transportation: The first item to be listed here is the provision of adequate aisle space. These aisles must be of sufficient width to take care of all trucking and they should be kept clear even if it is necessary to paint them.

Layout is also affected by the newer methods of inside shop transportation, such as gravity shutes, travelling hoists, and belt or link conveyors. In plants where the layout, because of peculiar situations, cannot conform to a straight line, the best possible use of inside transportation is an exceedingly important factor. The handling cost of material is often a very important factor in the cost of the product and every practical device or mechanism should be employed to reduce this cost. Gravity, the cheapest conveyor of all, should be used wherever possible.

(4) Proper balance of departments: The proper balancing of the sizes of departments eliminates limiting or bottle necking of operations within the plant. The capacity of each department or machine should be such as to allow for full time use of the equipment, be able to take care of all the material which is passed to it from the prior operation, and should produce sufficient to supply the machines or department of the next operation. Any other arrangement involves increased inventories of work in process, overtime work, with its attendant increased costs and general confusion including utilizing of expensive factory floor space for material tied up while in process.

The individual case will show varying degrees of departure from these principles as stated, but they must be essentially fulfilled to obtain better results and the efficiency of production will be increased as this is done.

OBJECT OF INVESTIGATION

The purpose of this investigation is to revise the layout of the heel trimming department at the Revere Rubber Company and to combine with it in the same room the sole trimming department which at present is in a different building of the plant. The Revere Rubber Company, a Rhode Island Corporation, is a subsidiary of the United States Rubber Company which is a holding company for a large number of operating companies which manufactures a wide variety of rubber products .

Included in this list of products are tires, raincoats, rubberized belting, heels, soles, rubber mats, steering wheels of hard rubber, and one hundred and one other products. The list is constantly expanding as rubber is adapted for more and more uses. These operating companies have their own names but the central management (the U. S. Rubber Company) decides questions of policy, what they will manufacture and in what quantities. The products are sold through a sales organization which is called the U. S. Rubber Company and Associated Companies. The plant under discussion is located in Chelsea, Massachusetts on the line of the Boston & Maine Railroad.

This corporation (Revere Rubber Company) was preceded by a Massachusetts Corporation of the same name which in turn was preceded by the Boston Elastic Fabric Company. This first company was established in 1863.

The first goods manufactured were elastic cords and braids made on braiding machines; and rubber thread used in the manufacture of elastic goods. Later, woven elastic goods for the dry goods trade was made by this company. The next product to be added was webbing for suspenders which was followed by the production of complete suspenders. In 1867 this company commenced to manufacture belting, hose and packing and other mechanical rubber goods.

In 1884 a large part of the plant was destroyed by fire and they then discontiued the manufacture of elastic goods and suspenders.

As far as can be ascertained this plant was located where it is because the principle stockholders of the fabric company at the beginning were also the principle stockholders in a land company which owned a large section on land in this city.

The Boston Elastic Fabric Company was founded in 1863 by Joseph W. Clark, a State Street banker.

Capital stock amounted to $268,000, this amount $250,000 was paid to L. Hull for his patents for the manufacture of elastic cords, braids and Rubber thread.

In 1867 the capital stock of the company was re-issued on a basis in order to pay the debts of the company.

In 1864 the capital stock was increased from $268,000 to $400,000. In 1871 an additional $100,000 of capital stock was issued.

In 1881 a Boston banker bought up all the stocks and again the company was reorganized and the capital stock increased to $600,000. The new management developed the company very rapidly. However, the records show that in twenty years, from 1863 to 1883 only two dividends were paid, one in 1872 of 3½% and another in 1879 of 3%. The stock holders finally lost their entire investment.

In March 1883 a Massachusetts corporation bearing the name of "Revere Rubber Company", was organized with a capital stock of $500,000. This new company took over the property and business of the old company and also assumed its debts. The first president was E. S. Comverse.

In 1884 fire again demolished a large part of the plant.

In 1887 a new management built up a rapidly growing and

successful business and created for the company a high reputation for quality and service.

In 1892 the capital stock was increased to $1,000,000. In 1896 the stock was again increased, this time to $1,500,000. In 1907 the capital stock was increased to $2,000,000.

In 1909 the entire stock was acquired by the United States Rubber Company and since that time its history is part of the history of the big company.

With this sketch of thecompany, its organization and operation in mind, the following discussion will be perhaps more comprehensive to the reader.

The policy of the organization is to have each factory specialize in a group of products of products manufactured in such large quantities as to make possible the savings of large scale production. The Revere Rubber Company specialized in rubber heels, soles, and top lifts, these latter being sheets of sole rubber from which the cobbler cuts the small heels for women's shoes, rubber belting and rubber tiling. This latter has a widely expanding market and the tiles are used to finish floors in large office buildings, street cars, ships, elevators, houses, in fact they can be

used almost anywhere that an excellent wearing floor material is needed which is also of good appearance. Rubber tiling has these qualifications.

The rubber heels which are made at this plant are of a very great variety both as to name and sizes and these conditions greatly complicate the planning and flow of work. The layout of the department will provide for a comfortable daily production of 150,000 pairs of heels per day. Some of these heels are made umder contract for heel manufacturers who sell them as their own products under various brand names. Others are manufactured in large lots and packed in wooden cases which are shipped to shoe manufacurers. Still others are packed in card board cartons of one pair to a carton and these are packed in large paper boxes which are sold to jobbers and shoe repair men. The soles are made under the name of "Uskide" and go through a similar procedure.

Referring to Appendix A. It will be seen that the heel trimming department is located in a room 200'X60' in the third floor of a modern factory building. There are a number of stone columns dotting the room the location of which are shown on this blue print. The arrangement of the equipment in the room as it is now is represented here.

The operations carried out in the manufacture of rubber heels are listed as follows: 1. compounding 2. mixing 3. calendering 4. dinking 5. curing 6. trimming and finishing.

MIXING

The purified crude rubber (in blocks) is mixed very accurately in the compounding room with the ingredients necessary to fill out the formula. The "batch" as it is called is placed in a metal container and carried by a small electric truck to the mixing room.

The operator is give the "batch" of rubber in this container. He starts with the rubber on the steam heated rolls and as soon as this is soft enough he adjusts the distance between them so that the layer of rubber carried aroung the near roll is just too thick to pass around it without being carried against the further roll so the plastic mass heaps itself a little between the two rolls, one roll of which moves slower than the other.

The operator then dusts the drugs or minerals onto the top of the rolls so that what is not at

at once caught up and buried in the rubber remains in the space between the rolls and is gradually absorbed instead of at once falling between. When all the minerals have been emptied onto the rubber, probably half or more will have fallen between the rolls and have been caught on a tray immediately underneath. The minerals that have fallen onto the tray are swept up by the operation with a small handbroom and dusted onto the rubber again, repeating the process until all the minerals are absorbed. To help the mixing, the operator slits the rubber at an angle half way across with a knife pressed against the roll as it moves in front of him and then folding the flap over onto itself. This helps to get the mixing uniform and prevents the layer of rubber from merely passing round and round on the roll without drawing the mineral in with it. When the mixing is finished the mass can be sheeted to any desired thickness.

The great art in mixing consists in distributing the minerals uniformly and regularly throughout the entire mass of rubber without overworking it.

CALENDERING

The mass of mixed rubber is fed between the rolls on one side and passes out in the form of a sheet on the other. In the three roll calender as used by this company, the two bottom rolls are doubly geared so that by means of a clutch they may be made to move at the same speed, or the lower one may be made to move more slowly. The latter combination is used when friction calendering. The rubber compound is applied between the top and middle rolls and is compressed to a sheet between these rolls.

This sheet of rubber which is of the thickness necessary for a given style of heel, is cut into sections and piled on small trucks which when loaded are hauled into the "dinking" room as it is called.

In the dinking room are a number of presses with which are cut out the "biscuits" or the rough shaped pellets of rubber which become the finished machine. These presses operated by electric motors are of very heavy construction. The strips of rubber is placed on the "table" of the press and the die is placed over it. By manipulating a foot pedal, the

operator brings down a swinging plate with tremendous force upon the die and forces it through the rubber cutting out a heel or sole. He repeats this process moving the die over the surface of the section until all the heels are cut out. The press is then halted, and the material removed from the "table." The "biscuits" are placed in metal containers and the web material is thrown aside to be run through the calendering machine again and thus there is no material wasted. (The material in this form is plastic and therefore it can be repeatedly rolled into whatever form desired. This is a great factor in reducing the cost of these rubber products. In making many die products the surplus or web material must be thrown away a condition which adds greatly to cost figures.) This job is dnne on a piece work basis, and the skill element shows itself in the rapidity of operation of the present and the number of heels obtained per section of rough stock,

From here the containers of "dinked" heels are taken to the press-room. The press building is a

three story building. The operation performed here is of shaping the heels, placing holes and metal washers in them and curing them.

The process of placing washers in the heels is an interesting one. The small steel washers are strung on long steel prongs by a clever little machine. The operator then takes these stacks of washers and distributes them over a large cast iron board on which are a number of imprints of heels, and the prongs on which to hang the washers. When he has distributed these washers, the board is placed in the press and the dinked heels placed in postion in the machine. The machine is then closed down, heat applied, and for ten minutes the heels are "cured". At the end of this time the machine is opened the heels are taken out, placed in metal containers and sent to the press-room on a roller conveyor system.

The heels are then brought from the press-room on the second floor of the next building by roller conveyors and are deposited at a weighing machine where they are checked as to number and weight and

then taken into the center of the room and stored in the space marked "Leading Platforms." When the girls need work, the men who use wooden trucks which are roughly in the shape of a rectangle 1½' wide, 2½' high and 5 ' long with small wheels attached to the bottom, truck the wheels which are in metal pans weighing eight pounds, contain on the average 147 men's heels, to the machine of the operator called a "trimmer." This trimmer using a trimming machine cuts the fringe of rubber from the heel and finishes the heel. The machine used by the trimmer is either a United Shoe Machinery Corporation machine which is one of the few machines sold to the heel manufacturer by this corporation, or it may be the one made up in the company's shops. The U. S. M. C. machine is the more modern type and although production figures are about the same for both machines the modern type is the safer one to work on. The machine is rather small, about the size of an ordinary sewing machine "head" and consists of two circular revolving discs which are sharpened on a bevel and work on the shearing principle of thescissors.

There is a small smooth metal platform which slants at the most convenient angle for working; the heel is placed on this and fed into the revolving knives which shear off the rubber and leave the heel ready to be inspected. The trimmed heel is passed on to an inspector who inspects for flaws due to pressing and who also inspects the trimming. The inspector also packs. Most of the heels are packed in bulk in wooden cases. Some of the heels are packed in individual pair boxes and then packed in cases. From the packer the case is moved to the nailing space where the top is nailed on and the case bound by a metal tape. The case then moves to a stencilling area and the necessary information is stencilled on. The case is then ready to leave the department. Rollers lead from the department to the storage floor below. The case is put on these rollers and is then storaged.

SCHEDULING.

The heels are processed in order lots. Cash orders are scheduled through each department in the process. The heel trimming machines are divided

into groups and the heel lots are scheduled to the group. However, since the pressroom operates twenty four hours a day and the finishing room only eight hours and twenty minutes, the heel finishing department must turn out in their eight hours and twenty minutes what the pressroom turns out in their twenty four hours. Therefore the heel trimming room is approximately twenty four hours behind the pressroom in the morning and sixteen hours behind at night. This is because the heels that are pressed by the pressroom in twenty four hours are finished in eight hours and twenty minutes.

STORAGING OF UNFINISHED HEELS.

The heels come from the pressroom on a conveyor which runs into a doorway to the weigher. (Appendix A). The weigher checks the count in each container by use of a scale. He then places the container on a wooden loading platform and when the platform is loaded it is moved to the storaging area in the center of the room, as shown in Appendix A. When the trimming operators start in the morning the

entire day's work is already stored on the floor. However, as the day progresses and vacancies appear in the storaging area, the heels that are to be finished the following day are stored in the same area. This is due to the fact that the pressroom has already started to press heels that are to be finished the following day. From this storaging area the work is delivered to the trimming operators by men who dump the heels alongside the operator.

METHOD OF PROCEDURE:-

The authors first made a visit to the plant to meet the executives of the plant, that they were to come in contact with, and also the foremen of the heel and sole finishing departments.

At this interview Mr. George Parker, assistant superintendent of the plant, was our guide. He explained the functioning of the departments and the desired results were given us. All the machinery and equipment were also inspected. Mr. Parker told us at this time of the problem and the following few visits were spent in watching the operators and in tracing out the flow of work. A questionaire was then drawn up which contained the following questions.

1. Is the entire day's work for the heel finishing department all ready for finishing when the night shift in the press room quits?

2. If so, where is the material placed in the department?

3. Is any work that is weighed by the checker in the heel trimming room trimmed the same day?

4. What is done with the metal container in

which the heels travel, after the heels are dumped by the operators?

5. What is the flow of the heels that require cleaning?

6. What is done with heels that have been taken out by inspectors as defective?

The procedure after this was to make a layout sketch of the department and to show on this layout the flow of work as we found it. Measurements of all machine-tables and other equipment were taken and also their relative positions in the room were measured. During this time we received much valuable information from the employees of the department, which helped form our background so necessary to an intelligent understanding of the problem.

A drawing was next made showing the positions of the machinery and equipment and flow lines were placed on this drawing to show the flow of work through the department.

Interviews were then arranged with the superintendent, industrial relations department, time study department, scheduling department and cost

accounting department. A discussion was held at every visit with the assistant superintendent at which times we told Mr. Parker what we were doing and asked him about which we were having difficulty in securing information.

At the interview with the superintendent possibilities and cost of new equipment were discussed. We, also, attempted to get the management's viewpoint of increasing production by the use of more modern equipments.

At the interview with Mr. Curry, of the Industrial Relations Department, labor problems which might arise were discussed. The training requirements and possiblities of hiring men were thoroughly investigated, and management's objections and preferences were examined.

Trouble was for the first time encountered in the securing of information when we attempted to get figures from the cost accounting department. Very little accurate information was obtained from this department. The only figure that they would divulge was the percent

of direct labor which is added to these labor charges to get a figure known as manufacturing cost. The additional cost of productions is overhead. The desired figures were figures of supervision charges distinct from overhead charges. We are therefore forced to introduce a factor of inaccuracy of the solution of the problems.

We next obtained interviews with the Time Study Department and the Scheduling Department.

Figures were obtained from the Time Study Department as to daily producti on of the operators to compute the number of machines necessary to obtain the daily production desired.

New scheduling policies were discussed with the head of the Scheduling Department and compared with present methods.

Records of male and female labor employed monthly in the heel finishing department for one year beginning September 1927 to August 1928 were obtained from the employment and time-keeper's files. With this data and information at hand we performed various

calculations, read references, as listed in the bibliography, and discussed several plans for the solution of the problem.

We then transferred our attentions to the sole finishing department and obtained measurements of the machinery tables and equipment in order to determine the space necessary for the operation of this department.

After arriving at the conclusions we made a revised layout drawing, showing the combination of heel and sole trimming departments on one floor.

INTRODUCTION:

Having collected all the data as described above the authors proceeded to examine them for all possible solutions which would have incorporated in them a mininum expense charge and the most desirable of results as compared with the present arrangement. One can see that the ideal solution would have been arrived at following the principle laid down in another part of this report, is not possible due to limitations placed on us in the way of present location, shape, size of building, existing methods of production in the department before the finishing department and the above mentioned necessity for mininum expenditures.

DESIRABILITY OF COMBINING HEEL AND SOLE FINISING DEPARTMENTS:

In the combining of the sole and heel trimming departments there will be several advantages obtained which should result in lowered operating costs. At present the sole trimming is carried out in an area 52'x 101'. In this area there are other operations performed but the bulk of the room is used in the process of sole trimming. If the sole trimming were done in the same room as the heel trimming a large area would be made available for other work.

At present there is a foreman of the sole finishing department who would be made unnecessary if these two departments were combined. We think it possible for one man to supervise the two departments and that either one of the men now occupying these positions could take the added responsibilities.

With the above two methods of reducing the cost of the product, that is cost of supervision, and overhead charged to space occupied, there is a real advantage in combining the two departments. Further more, the space occupied by the heel finishing* department is cluttered up with tables and machines which are either in the wrong position or are altogether unnecessary in the course of the work. By removing this unnecessary equipment and rearranging it, more room is available and a higher level of all around efficiency will result.

FLOW-SHEET:

With these conditions in mind the study was continued, and the flow-sheet of the department which the authors constructed was consulted. This flow-sheet being a small scale

* Heel finishing or trimming departments are one and the same.

two dimentional representation of the physical aspects of the situation was found to be very helpful in giving a bird's eye picture of the situation and affording a means of trying various types of layout before they are actually constructed. The proper conception of the relation between the dimensions on paper and the actual is one of the difficult points which are met, but this may be overcome by a little concentrated study of comparative distances on paper. To give an example, the most difficult thing for one to allow for is sufficient space for aisles. These spaces appear very much distorted when viewed in the small scale of the flow-sheet. In our case we used three sixteenths of an inch as representing one foot and used the scale lavishly in checking every dimension especially where the flow of work made it essential that sufficient aisle space be allowed for.

PROVISIONS FOR MAXIMUM PRODUCTION:

One of the most important conditions under which this investigation was conducted was that in the revised layout of the departments, there should be ample equipment and enough available production room to take care of a daily production schedule of one hundred-fifty thousand pairs of heels and seventy-five thousand pairs of soles.

These provisions seemed rather out of proportion to the actual needs of the department since at the time of this investigation this department was operating at from thirty to forty thousand pairs of heels per day.

Through a study of heel production figures for the yearly period 1927-1928, it was brought out that maximum production occurred in May and June of the year and there were very large fluctuations from maximum for the rest of the year. This maximum was about one hundred thousand pairs of heels. The production schedules were set by the sales department of the company who supposedly were competent to forecast the sales and from the sale, the production figures which the Revere Rubber Company operated on. However, something was radically wrong with this system as can be seen by an examination of the production figures of Appendix C.

It should be appreciated that this forecasting of sales is a subject which is greatly complicated by anynumber of variables whose effects on the sales of a product it is almost impossible to predict. The large number of styles of heels produced by the company and the disordered condition of the rubber industry, and also, the shoe industry should be here introduced as mitigating circumstances in favor of the sales planning organization.

However, the need of providing for the future expansion and the strong opinion of the management that these estimates were not too large, rationalized these provisions and they were used in the working out of a layout.

One of the peculiarites of the situation was the fact that the machines used for trimming could with two or three minor adjustments be used as a sole trimming machine. Coupled with this fact was the information that the peak production for heels never has coincided with that for soles and therefore we should be able to use certain equipment for either the sole or heel trimming functions without the danger of being unable to take care of loads. The proportion of machines to be thus exchanged between sole and heel trimming was set at ten machines by the following method. The production of soles for the year remained constant at forty thousand pairs daily output. The output of the operators of sole trimming machines from studies of time cards was found to be from four thousand to forty five hundred soles per day. This would necessitate a provision for twenty machines allowing for the fact that two or three machines will be always in repair. The remaining

machines could be secured from the sole trimming department and since these two departments will be in the same room, the layout can be made so that the machines will be close enough to the sole trimming area to afford efficient production. There is here interjected the problem of securing operators to run these heel trimming machines as sole trimmers. After discussing this problem it was decided that ten or twelve heel trimmers would be maintained as a floating force between heel and sole trimmers and these operatirs would be trained in the operation of a sole trimming machine at a wage which would be computed as the average of their earnings for a period of three or four months previous. No difficulties were anticipated in the operation th this part of the plan because of the similarity between the two operations and the fact that the earnings of the operators of these machines were very nearly the same.

The number of machines which were laid out for the sole trimming department were set at seventy six. The production of the sole trimmers ran at about four thousand heels per day, per operator, With the use of seventy six machines the peak of one hundred fifty thousand pairs could be attained. In laying out the space alloted per machine a value of three and one third feet per machine

was chosen as representatives butthis space is actually three feet or somewhat less. In the actual installation of machinery, it is recommended that the tables be constructed of the lengths shown in Appendix B and the machines mounted in them. Any excess space may be reserved either as room for the placing of extra materials or, on occasion, as the settings for such additional machines as may be needed to accommodate the production schedule. In this connection it should be stated that adequate machinery is available from the store rooms of the company to take care of any layout of equipment which this investigation will indicate without making it necessary to purchase any outside in the market.

STORAGE OF UNTRIMMED HEELS

The storaging of heels in the center of the work area as is the present practise has many undesirable features. In the first place the storage takes up a very large portion of the floor area that could be utilized for production. The room is at all times cluttered up with tope boxes filled with heels. Straight line flow of work is made impossible and much unnecessary trucking is

involved in this arrangement. It would be far more desirable to have the heels trimmed direct as they are brought from the pressroom on the roller conveyors. It was intended by the authors to have this arrangement incorporated with the new plan but limitations in the productive equipment of the pressroom preclude this possibility. The pressroom whence the heels are sent to the finishing room is a "neck in the bottle" department which it is so desirable to avoid but we do not think it wise to recommend that the capacity of this department be changed so that production in the heel trimming departments can be synchronized with it due to the large outlay for new equipment which is at once necessary and which present productive demand does not indicate, is wise.

Under these conditions it is necessary to have storage somewhere between the pressroom and the finishing room. An examination of the pressroom indicated that only a limited amount of work can bestored and there would be not nearly enough room to store the full capacity production. Knowing this it is only a question of storing

the material where it is most conveniently handled, where it will not interefere with trucking operations, and where a minimum of wasted productive area will result.

Reference to the areas marked "Storage" on the revised and combined layout of the two departments will show where the authors thought the most convenient areas to store the unfinished work. It will be noted that in all cases where this work is directly in back of the machines the work flows in a straight line the process of trimming, inspecting, packing and on into the stencilling area.

In the sole finishing department and two rows of machines adjacent to it there is no provision made for a full daily storage of materials. The arrangement in the sole trimming is to store the material to be processed in the pressroom and to send it up in such quantities as are necessary to maintain production at the sole trimming machine.

In the case of heel trimming machines a portion of the production that is being pressed in the

pressroom can be sent directly to these machines for processing thus relieving the necessity for storing furthermore. These two lines can be used to do rush work or other special kinds of heels or jobs which are the result of special orders rather than part of the regular daily routine production.

One rather novel provision which the authors feel should be introduced is the storing of three pans of materials under each machine.

These pans can be hung on racks made of wooden slats nailed on the legs of the tables and the proper distance separating them to allow for the storing of these three pans.

It has been calculated that each operator will use one pan every twenty minutes or an average of three pans per hour. Thus there will be stored at each work bench (but not directly in front of the operator's seat) one hour's work. The operator will work twenty minutes and then have to lift a pan from these racks to the table. This movement will afford some relief from the fatigue which results from working in one position for

a long period of time and which can be lessened by a change of movement and position. Then once an hour the operator will carry three pans of heels over to the machine and rack them. This will afford a still greater relief from the effects of fatigue.

Nothing very much is known by the average factory worker about fatigue but scientists know that to it may be directly traced the deleterious effects of so called over work. It lessens production, cuts down the physical health of the worker and lessens efficiency of production. It is trace directly to the poisons generated by the physical work performed by the worker and is very powerful. Its effects are cumulative and the only way to lessen or offset its effects is to have the blood carry it off to the lungs where it is purified. Obviously in order to accomplish this the circulation must be stimulated so that increased flow of blood will do t his.

Applying the above discussion to our case we begin to see why movement on the part of the operators is desirable both from their own and the employing company's viewpoint.

Even though the operator may object and state that she is going to do less work, lose the time she would otherwise spend in trimming heels, and thus decrease the amount of money she will earn, it should be carefully explained to her why she is asked to do this work and she should be asked to give the method a fair trail with an open mind, and to see for herself that the pay envelope will not be depleted but very probably fattened, together with a lessening in the deadly monotony which is present in such a type of work.

WEIGHING AND CHECKING OF HEELS

In transmitting the heels from the pressroom to the trimming room it is necessary that they be weighed and the number checked. At present this is done at the entrance to the trimming room as examination of the flow sheet Appendix A will show. There was the question raised as to the desirability of maintaining the scale in this position. During the day when the man at the scale could not weigh the pans of heels more rapidly than they were placed on the conveyor at the pressroom, they accumulated on the conveyor and in time

there was no room left on the conveyor and the heels were stored all around the press room. During the discussion it was thought that the logical position for the scale was at the other end of the conveyor in the press room because the weigher would be better able to secure the pans of heels and weigh them. Furthermore, with the scale in the press room, the pans would be placed directly on the conveyor after weighing and would be taken from it on the other end by truckers, who would load it onto their trucks as it came along and after filling the truck up, could distribute them in their proper places, without waiting for them to be weighed. With the proper synchronization between the press room production and the weigher there would be no congestion at the scale. At present the weigher weighs 85.4 pans per hour as calculated from his time over a period of months. This extremely low weighing rate is due to his weighing the heels and carrying them into the center of the room for storing. It is this carrying of heels into the storage area that decreases his weighing rate. We calculate that if he weighed alone he

could very easily increase his rate to the point where he could take care of the production from the press room. This fact would necessitate a readjustment of his piece rate scale that now includes the storaging time.

It is recommended that in this readjustment no change be made in his weekly aggregate salary, at least not in the downward direction because this job requires a type of skill and rapidity of movement not usually found in the average factory worker. Furthermore, the authors found in examining this process, that the man engaged in it was very skillful and showed a willingness to work and operate in anything asked of him, that was very unusual and we think that he is a very desirable person to have in the employ of the company.

MACHINES USED IN THE PROCESS

As described in a foregoing section of this report the machine used is a simple arrangement of revolving knives which knives cut off the fin of rubber resulting from the press room operation. There are

two types of machines used by the Revere Rubber Company and although they are similar in appearance and construction the United Shoe Machinery Company holds patents to the better one. The others are manufactured in the machine shops of the company. The United Shoe Machinery Company's machine does not turn out any more work than the other one but it's redeeming feature is the principle operation which makes it impossible for the operators to cut themselves on the steel knives. They are also more prepossessing in appearance than the company's machine which is made up of a few castings and machined parts. We thought of the possibility o f improving their machine but decided that that of the United Shoe Machinery Company was about as good as could be designed under the circumstances unless one went into the field of automatic machinery where the heels would be rotated by a cam affair, around the knives. We do not think that these heels would lend themselves to such automatic treatment because of the variations in sizes of heels and the time which would

be wasted in setting the machine for different varieties of heels. The flexibility of the heels themselves, are also an obstacle which might prove unsurmountable.

TIME STUDIES

There is a time study department in the plant which periodically examines the various operations and sets standards for them. After observing the girls at work in the department we came to the conclusion that the percent of waste motion which was incorporated in their movements was but a very small percent of the total trimming time and that improvement was not possible. The operation is so simple that it isn't easy to see where waste movement could come into the picture. The operator sits in the seat with a pair of heels at her right hand. She merely reaches out, picks a heel out of the pan and lays it on the cutting platform, simply, and without any complicated movements.

PERSONNEL

It has been the policy of the management to divide up all the work among the operators. Very few are laid off in the slack seasons. It is easy to appreciate this policy if one considers that is takes a number of years to make a fast trimmer. If these trimmers are laid off in slack seasons they would probably go into another line of business and the management of this plant would then have to train other operators. Therefore, by keeping all their operators they always have a fast and efficient crew. At present most of the operators have been with the Revere Rubber Company for four years. The length of time of service of most recent is two years, while a number have been there eight years. In times of peak production, the plant has a very efficient crew of trimmers and therefore, the work is turned out with a minimum number of operators and machines.

As before stated the trimmers are all female. At one time male help was utilized in conjunction with female as trimmers but the management soon did away the male labor. The male labor used were boys and young men. The objections to male labor from the managements

viewpoint are that in the first place they cannot be trained to work as fast because (1) they are not as adaptable to that type of work and (2) they do not remain at the work long being naturally more ambitious. A girl will go into this type of work and stay at it until she marries. A young man will take this work only for a short time. This is unsatisfactory from the managements viewpoint as it takes a number of years to train an operator to work at a rate of speed that would be most suitable.

There is also another angle to consider. It has been discovered by the industrial relations department that in departments where male and female employees do the same type of work, the male employees become dissatisfied. There is a psychological reason for this attitude. Male, who considers himself superior to female, is naturally dissatisfied if he is put in the same class.

From the above explanation it is obvious why only female help is utilized. The objection to female help, however, is that they are by statute law only allowed to work certain hours of the day and a night shift is impossible. Neither are they allowed to work

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overtime after six o'clock at night and in case of a sudden increase in production, which may only be temporary, it is necessary to increase the size of the crew if the present crew cannot handle the work.

The female operators are mostly all young women ranging from the ages of 18 to 24 years. Some of the operators who have been there for a number of years are slightly older that this. The type of girl employed is slightly above the average factory type as she must be very nimble with her fingers and have a quick reaction.

The inspectors do not require much training. They are also young women of about the same age as the operators.

The supervision consists of two or three women called foreladies. They are women of the executive type about 30 years old.

There is one foreman in the department. He has charge of all the operators of heel finishing.

The male employees in the department are weighers, checkers, feeders, truckers, mailers and case strappers, buffers, scrapmen, defective heel

sorters and packers, and a clerk. These men are from 25 to 50 years of age. The amount of training necessary for any of these functions is a very short period of time. However, there is a very small turnover in these jobs as the work is fairly steady and in most cases is almost constant whether production is high or low.

LABOR REGULATIONS

Another factor which was investigated in revising the layout was the labor regulations applying to female labor in factories. According to the labor laws of the State of Massachusetts a maximum of forty-eight hours per week and ten hours per day before six P.M. is allowed. The relation these provisions had to our problem was that with an unexpected increase in production which would last for perhaps one month or which might be even more spasmodic, the use of the medium of overtime work could be used to provide for this rush work instead of maintaining machines and personnel to take care of it. Also, if we had not been tied up by these regulations it might have been possible to use two shifts of operators who would work eight hours on each shift. These hours would possibly be seven in the morning to three in the afternoon, and three to eleven at night. The two shifts could be rotated to give everyone a chance to have their evenings free. Of course,

the advantages of this plan can be easily seen. The operators work shorter hours and will probably increase production through lessening of fatigue factors. They will probably work a little faster to earn a weekly pay equal to what they earned under the one shift system. The great advantage would be in the reduction of the number of machines necessary to maintain production schedules and the floor space necessary to accommodate them. This would represent a tremendous saving. The impossibility of using this solution to the problem is obvious under present conditions of government but in the alternate solution as explained in another part of this report, the use of men operators is developed along these lines. However, it is obviously foolish and inconsistent that these laws that allow women to work until six o'clock and not later in factories are not applied to other occupations more taxing to the strenght and vitality of women. Reference is made here to the large group of women who work in the innumerable

large buildings of the modern city, who clean and wash the buildings during the night. There is also an increasingly large number of women who are employed by the Federal Government in the capacity of postoffice clerks who work until eleven o'clock every night. There are others in the same department who work all day at other jobs and then come in to the postoffice to work until eleven o'clock at night, a daily average of approximately twelve hours. They average weekly amount to sixty eight or even more than seventy hours per week. One might say that this work cannot be compared to heel trimming, but the authors know from experience that if anything, heel trimming is less sapping of the energy and vitality of the worker than the other tasks.

However, with the trend of government regulation of labor and the increase in the rise of machinery in production, it is not at all likely that there will be any change in the labor laws that will allow more than a maximum of the forty-eight hours per week.

INSPECTION OF HEELS.

After the heels are trimmed, they are inspected by the inspector who sits in front of the trimmer and who also packs the heels. The inspector tests each heel for flexibility, correct width and shape, and the quality of the design and trademark of the heels. Any of the defective heels are thrown to one side. An examination of this particular phase of inspection left the impression that it was efficient and not too rigid. However, later examination proved differently. (See Defective Heels below.)

There are certain brands of heels and certain orders which undergo special inspection. These special tests consist of very rigid examination of the heels and the checking of the number of metal washers in them to see that they are all there. In addition to this type of special inspection, there is an inspection of the work of the men who place the washers on the moulding board in the pressroom. From each batch of heels coming

from them, one or two heels are extracted and tested for the number of washers. If an excessive number of defective heels are found, the pressroom operator is responsible and severly reprimanded. There is not much difficulty on this account, but it is probably true that the moral effect of this inspection is well worth what it costs since it maintains the quality of the heels.

DEFECTIVE HEELS.

As stated above in the Inspection section, the heels judged defective by the inspector are thrown to one side and are collected periodically and taken to an adjacent room where they are sorted. By this sorting operation, the heels that are thought possible to sell under the label "Defective" or "Seconds" are separated from those which must be melted up again and sent through the production process. The authors in their investigation ran across this defective heel process of examination and stopped to examine the large quantity of defective

heels. After picking two or three and finding nothing wrong with them, they asked the foreman of the heel trimming department, who was with them, what was wrong with these heels. He examined them and found them to be of first quality and returned them to the production department. He then picked a few more from the heap and foundthem to be of sufficiently good quality to make them saleable as first-class merchandise. It certainly looked as though something was wrong. The fact that the inspectors of heels are paid a bonus for defective heels found is perhaps the root of the trouble. It is only human for one to lean on the wrong side when one is in doubt, and when an inspector runs across a heel that is near the line, she would quite naturally and with no dishonesty, reject it as defective. However, something is obviously wrong with the inspection system, but the use of more active and critical supervision in the line of these defective heels should help to eliminate some of the

unfortunate features. The inspectors should not be paid a bonus for defective heels. They should, however, get a raise in salary which would be computed in the following way: Calculate the average weekly amount of defective heels and reduce this to bonus per one humdred heels, the unit of production used in the department. Add this to the rate for inspection charges per hundred heels and an increase would result whose raison d'etre should be explained to the inspector and she should be admonished to use more care in her inspection work. By this method, the total loss would not be stopped because the inspector is still being paid a bonus on the basis of heels she calls defective, but a large saving would result since the heels saved could be sold as perfect goods.

INSPECTION OF SOLES.

The inspection of soles is too rigid and repeats itself too much. One inspecting operation should tell whether the sole is perfect or defective. At present,

two or three inspections are performed on the sole before it is packed. The operation of inspection should be radically remodelled by the use of time studies. A new rate for inspection will be set which will be higher that the old because the inspector will not be able to examine so many heels as formerly but she will be examining for a number of qualifications which were not formerly included. In this way the number of inspectors will be decreased and supervision charges thus decreased very greatly and the space occupied by the department will also be materially reduced.

TOPE BOXES

In the transportation of the heels through the operations incedent to their manufacture, the heels are placed in metal containers 23 inches long, 15.5 inches wide and 6 inches high. They weigh 6 pounds per unit. As an effort to lighten the weight of the work which the girl operators must handle during the day it is recommended that fibre containers be substituted. These containers could be purchased

inexpensively and will weigh from one to two pounds per unit. Thus the load would be lightened from five to four pounds and these containers could be more easily transported than if they had been metal.

CARTONS

The heels which are packed in individual cardboard boxes are printed outside the plant. They are however, multigraphed with the size number and style according to the heel contained therein. For this reason the area near the elevator (See Appendix A or B) is devoted to the multigraphing of cardboard containers. There is a large variety of containers and these are kept in a large metal file. It is recommended that the cartons stored in these files be kept at a minimum by the procedure of printing only large quantities of the standard heels and sizes. There should be no stocked cartons of rare sizes and styles because they only serve to clutter up the files and a lot of time is used in searching for them when they finally are needed.

CONCLUSIONS.

I. At the present the layout of the room is such that the work does not flow smoothly. The room is very congested and cluttered up with materials. The layout of machine tables does not lend itself to flexibility. The machine lines running in different directions as these do (appendix A) is a very inflexible arrangement. A rearrangement of the room which would allow all machine tables to run in one direction would lend itself to flexibility. The work would also flow much smoother. An arrangement as shown in Appendix B would undoubtedly improve the flow of work and flexibility of operation.

II. The storaging of unfinished heels in the center of the work area as is the present practice takes up a large space that should be available for production. This practice also causes a large part of the congestion as mentioned in I of this section. This storaging could be done in a more advantageous way by storing work in long lines directly behind the machines instead

of congregating all the unfinished work in a central square area. The rearranged layout suggested would allow an increase in the number of machines, allow the work to be stored directly behind the machines and consequently eliminate one operation. The practice at present is to move the work first to the storage area and then from there to the machine when necessary. If the work is storaged in long lines directly behind the machines, one of these operations would be eliminated.

It has been found by the authors that it is possible to store three heel containers beneath the table alongside each operator by the erection of slides which would allow the containers to be slid in. As the average operator does one container full in 20 minutes, it is then possible to store one hour's work alongside of each operator. When the slides are empty the operator can herself fillthem from the storage behind her or else a man might go around filling the slides periodically. We believe that if the operator herself filled

the slides it would give her a rest and eliminate some of the fatigue.

III The sole and heel finishing departments are now entirely segregated. As the two departments perform basicly the same operations, the same operations, they should be all in one department under the same supervision. By rearranging the heel finishing room and storaging according to the previous conclusion it would be possible to move the sole finishing department into the heel finishing room and in this way combine the supervision which would be essentially the same and hence cause a reduction in overhead for both departments. In time of low production, it would also be possible to use indirect labor for both departments, and in this way eliminate idle time of the indirect labor.

IV In a previous part of this report it has been shown that the heel finishing department is twenty-four hours behind the press department in the morning and sixteen hours behind at night. This is mainly due to the fact that it takes the press department twenty-four

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hours to turn out what the heel finishing department turns out in about eight hours. However, in times of low production, the press room one shift at capacity, could turn out all the necessary production. Therefore if in these times of low production the scheduling department schedule directly to the trimming machines, all work pressed one day could be trimmed and finished the same day. This would do away with the twenty-four hour delay between pressing and finishing. In cases where the capacity of one shift in the press room is below the desired production figure, the sole presses could be used for heel pressing. This utilization of sole presses for heels is possible with a slight change in the machine. This would prevent a little of the excess production above the capacity of the heel press room from occurring. However, this can only be done in times of low production.

V Upon an investigation of the sole finishing department, we find that there is a great deal of unnecessary inspection. There is no apparent reason why one inspector could not do what three inspectors do now. The time of

inspection is very small but the time of moving the soles from one inspector to the next is very large. We find that there is entirely too much inspectionperformed on the soles . It is almost at the point where the other inspectors merely check the first inspector's work. By the elimination of some of this inspection, indirect labor charges would be decreased markedly and consequently the cost of production would be decreased.

VI In the heel finishing department we find that the inspection is very slipshod. Many perfect heels are thrown in with the defective heel causing a decided loss and consequently increasing the cost of production of the heels that are passed.

VII Of the production force necessary to turn out 50,000 pairs of heels per day there should be ten to twelve operators who will be trained in either sole and heel trimming to take care of peak production.

VIII The present position of the scales in theheel finishing department is not most advantageous.

IX The heavy metal tope boxes are too heavy for their purpose. A fibre tope box would be more advantageous and could be more easily handled by the trimmers.

RECOMMENDATIONS:

1. Combine heel and sole finishing departments.
2. Storage work as shown in the layout, Appendix B.
3. Reduce sole inspection after trimming to one inspector.
4. Change bonus method of payment for defective heels.
5. Rearrange heel finishing department as shown in Appendix B.
6. Rearrange sole finishing department as shown in Appendix B.
7. Place supervision of both departments under one foreman.
8. Use fiber tope-boxes instead of metal ones.
9. When operating in low production period, trim all heels and soles pressed same day.

Respectfully submitted,

David H. Wilson

Joseph L Speyer

COST OF RECOMMENDED ACTION.

The cost of the foregoing recommendations is estimated at $3,000. This figure was arrived at by the engineering department of the Revere Rubber Company.

Respectfully submitted,

David H. Wilson

Joseph L. Speyer

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APPENDIX C.
PRODUCTION FIGURES FOR SOLE AND HEEL

TRIMMING DEPARTMENTS IN 1928.

1928	No. Work Days.	Pairs of Soles	Pr. per	Pairs of Heels	No. Pr. Per day.
Jan.	22	700,000	31800	1,600,000	72650
Feb.	21	890,000	42400	1,540,000	73250
March	23¼	1,120,000	48180	2,100,000	90,400
April	21	863,000	41100	1,570,000	74,700
May	23	1,080,000	46,900	1,950,000	84750
June	21¼	900,000	42300	1,720,000	80,900
July	22	720,00	32,700	1,356,000	62,100
Aug.	24	740,000	30,800	1,780,000	74200
Sept.	20¼	326,000	16,200	1,500,000	74,200
Oct.	23	178000	7,730	1,680,000	73000
Nov. -	22	403,000	18,310	1,580,000	71,800
Dec.	21¼	433,300	20,380	1,530,000	71,900

SATURDAYS ARE COUNTED ONLY AS ¼ WORKING DAY BECAUSE THE PLANT IS CLOSED DOWN DURING MANY OF THEM.

APPENDIX D.

ALTERNATE SOLUTION.

Another solution to the problem of increasing production would be by running three shifts in the heel finishing department. This would require much less space than is required at present as only one third the amount of labor is at work at one time.

As female labor is cheaper than male, it is the opinion of the authors to employ female labor during the night hours. Statute law prevents the employment of female labor after six o'clock at night.

Male labor could be trained to handle the work as well as female labor. The labor is not essentially of a high grade of intelligence. Boys could be trained to do the work as well as women. The amount of training necessary to develope a heel trimmer to put out the average amount of production is three months. The training consists mainly in developing speed and habit. The skill required is very small. The operation as explained in a previous part of this report consists only of pushing the frayed edge of the heel under a cutting blade and twisting

the heel. The skill lies in the acquiring of speed in doing this operation. The utilization of male help for two more shifts would distribute some of the overhead over twenty four hours per day instead of the eight hours and twenty minutes per day as is now being done. The supervision expense, however, will be constant for each shift as well as the other indirect labor that will be required in the second two shifts. This indirect labor consists of the same type of work that is required in the first shift.

It will not be necessary to increase the direct labor cost on the heels as the male labor would be given the same piece rate as the female help is given in the first shift. Therefore there would be no increase due to direct labor charges. Therefore by distributing the total overhead cost less the supervision cost, less indirect labor cost over the twenty four hours, the cost of production per one hundred pairs of heels would be decreased.

However, this difference in overhead is so

small that the increase in supervision expense necessary to three shifts would overcome this saving in overhead. This is because the remaining overhead which could be distributed over the twenty four hour period is very small. The depreciation on machinery is negligible because the machine used is very simple and only parts of it wear out. The upkeep of the old machines is no greater than the upkeep of a new machine. A new knife, or belt or bearing might be necessary in a new machine as readily as it is in an old machine.

As to the turnover in labor: A turnover could be expected especially in the night shifts where the male help is employed. There is no possible way of measuring how big or small this turnover might be, however there are certain psychological conclusions which might be arrived at.

(1) Male help is naturally desirous of advancing,

therefore he will not stay on this "blind alley" job any longer than he has to.

(2) The kind of male help that would be employed would be young mainly boys. Older men could not be obtained at the salary that they would receive. It is only natural for a young man or boy to want to spend his evenings in recreation instead of working, therefore he would be constantly on the lookout for day work and in time would leave his night job.

Therefore it is the conclusion of the authors that the turnover would be high.

One important feature however to the benefit of three shifts would be the increase in space that would be available. This would eliminate much crowding and therefore allow a smoother flow of work, less congestion and more flexibility.

Upon weighing the foregoing analysis, it is the opinion of the authors that it would not pay to run three shifts because of the increased cost that would sprout from this condition. This is beeause

the overhead over and above supervision and indirect labor is negligible when compared to total overhead cost.

APPENDIX E.

EMPLOYMENT STATISTICS

For year 1927-1928

Female	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Trimmers	48	48	46	44	44	35
Inspectors	24	24	23	22	22	17
Boxers	9	9	9	9	9	6
Printing Press	3	3	3	3	3	
Return Goods						
Super Inspection	1	1	1	1	1	1
Odd Heels	1	1	1	1	1	1
Defective Heels	1	2	1	1	1	1
Check Defective Heels	1	1	1	1	1	
Inspection and Packing	1	1	1	1	1	
Heel washers			2	1		1
Forelady	3	3	3	3	3	2
Totals	92	93	91	87	86	64

Male						
Foreman	2	2	2	2	2	2
Nail on Top	1	1	1	1	1	1
Clerk	1	1	1	1	1	1
Feed Supply to Job	2	2	2	2	2	1
Sort and Pack Dept.Heads						
Weight for count	3	3	3	3	3	2
Truckers	3	3	3	3	3	1
Feeders	2	2	2	2	2	1
Checkers	2	2	2	2	2	1
Scrapmen	2	2	2	2	2	2
Expert Supervision	1	1	1	1	1	2
Inspectors	1	1	1	1	1	1
Less than caselots	1	1	1	1	1	1
Buffers	1	1	1	1	1	1
Sweepers	1	1	1	1	1	1
Returned goods and shippers	1	1	1	1	1	1
Totals	24	24	24	24	24	19

EMPLOYMENT STATISTICS

FOr year 1927-1928

Female	March	April	May	June	July	Aug.
Trimmers	45	45	48	47	44	46
Inspectors	15	15	15	43	22	23
Boxers	9	9	9	9	9	9
Printing Press	3	3	3	3	3	3
Return Goods	2	2				
Super Inspection	1	1	1	1	2	2
Odd Heels	1	1	1	1	1	1
Defective Heels	1	1	1	1	1	1
Check Defective Heels	1	1	1	1	1	1
Inspection & Packing	1	1	1	1	1	1
Heel Washers	1	1	1	1	3	2
Forelady	3	3	3	3	1	3
Totals	83	83	84	91	93	92

Male						
Foreman	2	2	2	2	2	2
Nail on Top	1	1	2	2	2	1
Clerk	1	1	1	1	1	1
Feed Supply to Job	2	2	2	2	2	2
Sort & Pack Dept. Heads	1	1				
Weight for count	4	4	3	3	3	3
Truckers	4	4	4	4	4	3
Feeders	2	2	2	2	2	2
Checkers	2	2	2	2	2	2
Scrapmen	2	2	2	2	2	2
Expert Supervision	1	1	1	1	1	1
Inspectors	1	1	1	1	1	1
Less than Case lots	1	1	1	1	1	1
Buffers	2	2	1	1	1	1
Sweepers	2	2	1	1	1	1
Returned goods and Shippers	1	1	1	1	1	1
Totals	29	29	26	26	26	26

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THESES

BETTS	Course XV	1925	No. 7
BOVEY & DRISCOLL	Course XV	1922	No. 12
ENWRIGHT & QUARLES	Course XV	1924	No. 16
DAVIDSON & HUBBARD	Course XV	1928	No. 17